APPENDIX 2

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61. method for designing, deploying or optimizing a communications network, comprising the steps of:

generating a computerized model of a space, said space having a plurality of different objects therein each of which may have attributes which impact performance of a communications network;

modeling performance attributes of a plurality of different components which may be used in said communications network;

specifying components from said plurality of different components to be used in said communications network;

specifying locations within said space for a plurality of different components in said computerized model; and

predicting one or more performance metrics for said communications network according to the generic form of the equation

$$X=C_1(Ad+Bd^2+C)+C_2(D(RSSI)+E(RSSI)^2+F)+C_3\sum_{i=1}^{M}(G_iP_i+K_i)$$

where X is the performance metric, *d* is the distance between a transmitter and a receiver, *RSSI* is a power level of signal at a receiver either in absolute value or logarithmic values, and *A, B, C,* C_1, C_2, C_3, *D, E, F,* and K_i are constants or represent linear or nonlinear functions of one or more physical or electrical parameters, and may include the effects of multiple transmissions, and the value *M* denotes a number of multipath components from one or more transmitters, and G_i

and P_i respectively represent gains and power levels.

62. The method of claim 61 wherein said computerized model generated in said generating step includes objects which create noise or interference, said noise or interference being an attribute of said object which is factored in said predicting step.

63. The method of claim 61 wherein said performance metric predicted in said predicting step is predicted in a forward direction in said communication network.

64. The method of claim 61 wherein said performance metric predicted in said predicting step is predicted in a reverse direction in said communication network.

65. The method of claim 61 wherein said computerized model is three dimensional.

66. The method of claim 61 further comprising the step of specifying data transfer protocol, and wherein said predicting step uses a specified data transfer protocol as a factor in predicting said performance metric.

67. The method of claim 61 further comprising the step of specifying a network loading for said communications network, and wherein said predicting step uses a specified network loading in predicting said performance metric.

68. The method of claim 61 further comprising the steps of:

measuring said performance metric for said communications network within said space; and

modifying predictions made in said predicting step based on measurements made in said measuring step.

69. The method of claim 61 wherein one or more performance metrics are selected from radio signal strength intensity, connectivity, network throughput, bit error rate, frame error rate, signal-to-interference ratio, signal-to-noise ratio, frame resolution per second, traffic, capacity, signal strength, throughput, error rates, packet latency, packet jitter, symbol jitter, quality of service, security, coverage area, bandwidth, server identification parameters, transmitter identification parameters, best server locations, transmitter location parameters, billing information, network performance parameters, C/I, C/N, body loss, height above floor, height above ground, noise figure, secure coverage locations, propagation loss factors, angle of arrival, multipath components, multipath parameters, antenna gains, noise level reflectivity, surface roughness, path loss models, attenuation factors, throughput performance metrics, packet error rate, round trip time, dropped packet rate, queuing delay, signal level, interference level, quality of service, bandwidth delay product, handoff delay time, signal loss, data loss, number of users serviced, user density, locations of adequate coverage, handoff locations or zones, locations of adequate throughput, E_c/I_o, system performance parameters, equipment price, maintenance and cost information, user class or subclass, user type, position location, all in either absolute or relative terms.

70. A site specific method for designing, deploying or optimizing a communications network, comprising the steps of:

generating a computerized model of a space, said space having a plurality of different objects therein each of which may have attributes which impact performance of a communications network;

modeling performance attributes of a plurality of different components which may be used in said communications network;

specifying components from said plurality of different components to be used in said communications network;

specifying locations within said space for a plurality of different components in said computerized model; and

performing one or more of

a) relating one or more empirically measured network performance metrics to a predicted performance metric,

b) obtaining one or more predicted or preset performance metrics, or

c) providing or generating a prediction of a performance metric,

wherein the performance metric is computed using the attributes of said objects, the attributes of said components, and said locations of said components, using a look up or interpolation procedure.

71. The method of claim 70 wherein said one or more performance metrics are selected from radio signal strength intensity, connectivity, network throughput, bit error rate, frame error rate, signal-to-interference ratio, signal-to-noise ratio, frame

resolution per second, traffic, capacity, signal strength, throughput, error rates, packet latency, packet jitter, symbol jitter, quality of service, security, coverage area, bandwidth, server identification parameters, transmitter identification parameters, best server locations, transmitter location parameters, billing information, network performance parameters, C/I, C/N, body loss, height above floor, height above ground, noise figure, secure coverage locations, propagation loss factors, angle of arrival, multipath components, multipath parameters, antenna gains, noise level reflectivity, surface roughness, path loss models, attenuation factors, throughput performance metrics, packet error rate, round trip time, dropped packet rate, queuing delay, signal level, interference level, quality of service, bandwidth delay product, handoff delay time, signal loss, data loss, number of users serviced, user density, locations of adequate coverage, handoff locations, locations of adequate throughput, E_c/I_o, system performance parameters, equipment price, maintenance and cost information, user class or subclass, user type, position location, all in either absolute or relative terms.

72. The method of claim 70 further comprising the step of predicting one or more performance metrics for said communications network.

73. The method of claim 70 wherein said performing step relates one or more empirically measured network performance metrics to a predicted performance metric.

74. The method of claim 70 wherein said performing step obtains one or more

predicted or preset performance metrics, or provides or generates a prediction of a performance metric.

75. A site specific method for analyzing a communications network, comprising the steps of:

generating a computerized model of a communications network within a physical space in which said communications network is or will be deployed, said computerized model identifying locations within said physical space of components used in said communications network, said computerized model having modeled attributes for each of said components, said computerized model may contain objects which model objects within the physical space which may have attributes which impact performance of the communications network;

positioning data collection measurement devices within said physical space;

identifying locations within said computerized model which correspond to said measurement devices;

measuring field measurement data with said data collection measurement devices; and

predicting one or more performance metrics for said communications network based on said computerized model and said field measurement data, said modeled attributes for said components, said modeled attributes for said objects within the physical space, and said locations of said components within said computerized model.

76. The method of claim 75 wherein said computerized model is three dimensional.

77. The method of claim 75 wherein said data collection measurement devices used in said positioning step are portable.

78. The method of claim 75 wherein said positioning step includes the step of affixing said data collection measurement devices permanently within said physical space.

79. The method of claim 75 wherein said one or more performance metrics predicted in said predicting step are selected from the group consisting of one or more performance metrics are selected from radio signal strength intensity, connectivity, network throughput, bit error rate, frame error rate, signal-to-interference ratio, signal-to-noise ratio, frame resolution per second, traffic, capacity, signal strength, throughput, error rates, packet latency, packet jitter, symbol jitter, quality of service, security, coverage area, bandwidth, server identification parameters, transmitter identification parameters, best server locations, transmitter location parameters, billing information, network performance parameters, C/I, C/N, body loss, height above floor, height above ground, noise figure, secure coverage locations, propagation loss factors, angle of arrival, multipath components, multipath parameters, antenna gains, noise level reflectivity, surface roughness, path loss models, attenuation factors, throughput performance metrics, packet error rate, round trip time, dropped packet rate,

queuing delay, signal level, interference level, quality of service, bandwidth delay product, handoff delay time, signal loss, data loss, number of users serviced, user density, locations of adequate coverage, handoff locations or zones, locations of adequate throughput, E_c/I_o, system performance parameters, equipment price, maintenance and cost information, user class or subclass, user type, position location, all in either absolute or relative terms.

80. The method of claim 75 wherein said step of measuring is performed manually.

81. The method of claim 75 wherein said step of measuring is performed autonomously.

82. The method of claim 75 further comprising the step of storing said field measurement data.

83. The method of claim 75 further comprising the step of updating said computerized model generated in said generating step.

84. The method of claim 83 wherein said step of updating includes the steps of:

specifying components from a plurality of different modeled components which are to be used in said communications network, said modeled components including descriptions and attributes of a specific component; and

specifying locations within said space for a plurality of different

components in said computerized model.

85. The method of claim 84 wherein said step of updating further includes the step of specifying an orientation for at least one component specified in said specifying components step at said location specified in said specifying locations step.

86. The method of claim 75 wherein said computerized model in said generating step identifies orientations of said components at said locations within said physical space and said predicting step utilizes said orientations.

87. The method of claim 75 wherein said computerized model generated in said generating step includes objects which create noise or interference, said noise or interference being an attribute of said object which is factored in said predicting step.

88. The method of claim 75 wherein said performance metric predicted in said predicting step is predicted in a forward direction in said communication network.

89. The method of claim 75 wherein said performance metric predicted in said predicting step is predicted in a reverse direction in said communication network.

90. The method of claim 75 further comprising the step of specifying data transfer protocol, and wherein said predicting step uses a specified data transfer protocol

as a factor in predicting said performance metric.

91. The method of claim 75 further comprising the step of specifying a network loading for said communications network, and wherein said predicting step uses a specified network loading in predicting said performance metric.

92. A site specific system for analyzing a communications network, comprising:

a computerized model which represents and displays a communications network within a physical space in which said communications network is or will be deployed, said computerized model identifying locations within said physical space of components used in said communications network, said computerized model having modeled attributes for each of said components, said computerized model may contain objects which model objects within the physical space which may have attributes which impact performance of the communications network;

data collection measurement devices positioned within said physical space, said data collection measurement devices being represented within said computerized model at locations that correspond to said data collection measurement devices, said data collection measurement devices measuring field measurement data for said physical space; and

prediction device for predicting one or more performance metrics for said communications network based on said computerized model and said field measurement data, said modeled attributes for said components, said modeled attributes for said objects within the physical space, and said locations of said components within said computerized model.

93. The system of claim 92 wherein said computerized model is three dimensional.

94. The system of claim 92 wherein said data collection measurement devices are portable.

95. The system of claim 92 wherein said data collection measurement devices are permanently affixed at said locations within said physical space.

96. The system of claim 92 wherein said one or more performance metrics selected from the group consisting of one or more performance metrics are selected from radio signal strength intensity, connectivity, network throughput, bit error rate, frame error rate, signal-to-interference ratio, signal-to-noise ratio, frame resolution per second, traffic, capacity, signal strength, throughput, error rates, packet latency, packet jitter, symbol jitter, quality of service, security, coverage area, bandwidth, server identification parameters, transmitter identification parameters, best server locations, transmitter location parameters, billing information, network performance parameters, C/I, C/N, body loss, height above floor, height above ground, noise figure, secure coverage locations, propagation loss factors, angle of arrival, multipath components, multipath parameters, antenna gains, noise level reflectivity, surface roughness, path loss models, attenuation factors, throughput performance metrics, packet error rate, round trip time, dropped packet rate, queuing delay, signal level, interference level, quality of service, bandwidth delay product, handoff delay time, signal loss, data loss,

number of users serviced, user density, locations of adequate coverage, handoff locations or zones, locations of adequate throughput, E_c/I_o, system performance parameters, equipment price, maintenance and cost information, user class or subclass, user type, position location, all in either absolute or relative terms.

97. The system of claim 92 further comprising a storage device for storing said field measurement data.

98. The system of claim 92 wherein said computerized model is stored on at least one server.

99. The system of claim 98 wherein said computerized model is stored on a plurality of servers, said plurality of servers can communicate with each other.

100. The system of claim 99 wherein said plurality of servers have a heirarchical relationship to one another in said system.

101. The system of claim 98 further comprising at least one portable client device that can communicate with said at least one server.

102. The system of claim 100 wherein said system includes a plurality of portable client devices.

103. A method for analyzing a communications network, comprising the steps

of:

generating a computerized model of a communications network within a physical space in which said communications network is or will be deployed, said computerized model identifying locations within said physical space of a plurality of components used in said communications network, said computerized model having modeled attributes for one or more of said components, said computerized model may contain objects which model objects within the physical space which may have attributes which impact performance of the communications network;

predicting, based on said computerized model, one or more performance metrics selected from the group consisting of

a) propagation delay information for said communications network,

b) frame error rate, bit error rate, or packet error rate,

c) round trip time or bandwidth delay product for said communications network,

d) throughput of information, and

e) quality of service information; and

outputting, storing or displaying said one more performance metrics.

104. The method of claim 103 wherein said one or more performance metrics in said predicting step includes a) propagation delay information for said communications network.

105. The method of claim 103 wherein said one or more performance metrics in said predicting step includes b) frame error rate, bit error rate, or packet error rate.

106. The method of claim 103 wherein said one or more performance metrics in said predicting step includes c) round trip time or bandwidth delay product for said communications network.

107. The method of claim 103 wherein said one or more performance metrics in said predicting step includes d) throughput of information.

108. The method of claim 103 wherein said one or more performance metrics in said predicting step includes e) quality of service information.

109. The method of claim 103 wherein at least some of said plurality of components that are modeled in said generating step are used in wireless communications, and wherein said predicting step factors in multiple transmissions and multipath delay attributable to placement of said components which are used in wireless communications.

110. A system for analyzing a communications network, comprising:

a computerized model which represents and displays a communications network within a physical space in which said communications network is or will be deployed, said computerized model identifying locations within said physical space of components used in said communications network, said computerized model having modeled attributes for each of said components, said computerized model may contain objects which model objects within the physical space which may have attributes which impact performance of the communications network;

predicting device for predicting, based on said computerized models, a performance metric selected from the group consisting of propagation delay of network information, bit error rate, frame error rate, packet error rate, bandwidth delay product, throughput of information, and quality of service, said predicting device making predictions based on said computerized model, wherein said performance metric may be computed using a combination of field measurement and predicted data; and

device for outputting, storing or displaying said performance metric.

111. The system of claim 110 wherein said predicting device predicts propagation delay of network information.

112. The system of claim 110 wherein said predicting device predicts bit error rate.

113. The system of claim 110 wherein said predicting device predicts frame error rate.

114. The system of claim 110 wherein said predicting device predicts packet error rate.

115. The system of claim 112 wherein said predicting device predicts at least one of round trip time and bandwidth delay product.

116. The system of claim 110 wherein said predicting device predicts throughput of information.

117. The system of claim 110 wherein said predicting device predicts quality of service.

118. A method for analyzing a communications network, comprising the steps of:

generating a computerized model of a communications network within a physical space in which said communications network is or will be deployed, said computerized model identifying locations within said physical space of components used in said communications network, said computerized model having modeled attributes for each of said components, said computerized model may contain objects which model objects within the physical space which may have attributes which impact performance of the communications network;

identifying locations within said computerized model which correspond to said measurement devices;

downloading or inputting files of field measurement data; and

predicting, based on the computerized model, a performance metric for said communications network based on said field measurement data, said modeled attributes for said components, said modeled attributes for said objects within the physical space, and said locations of said components within said computerized model.

119. The method of claim 118 wherein said field measurement data obtained in

said downloading or inputting step is specific for said physical space.

120. The method of claim 75 further comprising the step of updating the field measurement data obtained in said measuring step.

121. The method of claim 75 further comprising the step of updating the one or more predicted performance metrics obtained in said predicting step.

122. The system of claim 92 further comprising a means for updating the field measurement data obtained by said data collection measurement devices.

123. The system of claim 92 further comprising a means for updating the one or more predicted performance metrics obtained from said means for predicting.

124. The system of claim 110 wherein said predicting device uses a look up or interpolation procedure to relate one or more empirically measured network performance metrics to a predicted performance metric.

125. The system of claim 110 wherein said predicting device uses a look up or interpolation procedure to obtain one or more predicted or preset performance metrics, or to provide or generate a prediction of a performance metric.

126. The method of claim 103 wherein said predicting step uses a look up or interpolation procedure to relate one or more empirically measured network

performance metrics to a predicted performance metric.

127. The method of claim 103 wherein said predicting step uses a look up or interpolation procedure to obtain one or more predicted or preset performance metrics, or to provide or generate a prediction of a performance metric.